Earth and Space Science

Exploring Weather Patterns

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# Document Summary

This first grade unit presents an inquiry approach to the earth and space science standards while connecting to the grade one life science unit that allows students to explore backyard habitats and organisms. During this unit, students will observe weather on a daily and seasonal basis. The purpose of this theme is to connect earth and space science concepts to the life science unit on backyard habitats and their changes over time. Experiences in this unit can be done along with the life science unit or as an entirely separate component. The connections made in this unit serve to continue the spiraling of concepts first exposed in kindergarten and expanded upon in future grade levels.

The inquiry-based explorations in this unit encourage students to construct their own knowledge and challenge their misconceptions. During the inquiry process students will continue to develop the following:

* An understanding of the parallel processes
* Skill in using tools for observation, data collection, and design
* Increasingly sophisticated observation and data gathering

The first section of this document provides the language from the Massachusetts state frameworks that apply to earth and space science for the primary grades. These learning standards will be revisited throughout the primary grades. First grade students will not be expected to achieve mastery of these concepts, but should have an opportunity to enhance their ability to apply them.

The second section of this unit provides inquiry-based methods that facilitate the explorations. Each exploration centers on the following experiences:

* Discussion
* Setting the Stage for Inquiry
* The Inquiry Investigation
* Synthesis

The third section provides evaluative tools to support student learning and to inform instruction. Included in this section are the following tools:

* Key questions to be answered by the end of the unit
* Performance criteria for key questions
* Anecdotal record forms for skill standards
* Student/teacher conference sheets to support student achievement
* Performance products and performances to provide additional opportunities to demonstrate understanding

The final section of the document provides unit support materials. These materials include guidelines for research components, scientific vocabulary, and tips for facilitating inquiry in the classroom.

# Unit Overview

During this unit, students will expand their knowledge of earth and space science through the study of weather patterns. Students will observe weather using simple tools such as cups to collect rain and thermometers to measure temperature.

The pedagogy in this unit will encourage students to do the following:

* **Formulate testable questions**
* **Design independent investigations**
* **Observe and measure using scientific tools**
* **Collect and analyze data**
* **Synthesize findings**

Unit Objectives

Throughout the course of this unit, students will be able to do the following:

* Describe the weather changes from day to day and throughout the seasons.
* Describe that wind is moving air.
* Describe the repeating pattern of the seasons.
* Measure aspects of the weather such as wind, precipitation, and temperature.

# Standards

### Earth and Space Science

* Understand that air is a mixture of gases that is all around us and that wind is moving air.
* Describe the weather changes from day to day and over the seasons.
* Identify some events around us that have repeating patterns, including the seasons of the year, day and night.

Technology/Engineering

* Identify and describe the safe and proper use of tools and materials to construct simple structures.

# Key Questions

Key questions share the following characteristics:

* They are open-ended
* They require reasoning
* They raise additional questions
* They connect to the “big ideas” in the unit
* They can and should be revisited

By the end of this unit, students should be able to answer the following key questions:

* How would you describe the weather?
* How does the weather change over the course of a few days?
* How does the weather change over the course of the seasons?
* What seasonal patterns do we have in New England?
* What tools can we use to measure weather patterns?

# First Grade Toolkit

Students will carry out all investigations using scientific tools. The collection of tools most commonly used will be referred to as the “First Grade Toolkit.” Explicit instruction on the use of these tools will optimize the potential for student investigation, observation, and data collection. Use of these tools will create a high level of accuracy in collecting and recording observations and data. Subsequently, students will be able to apply observations and data in an authentic manner when drawing conclusions and proposing solutions.

Students are to use the following items as part of their repertoire of tools as they investigate throughout this unit:

* Science Journals – Students should record all questions, observations, data, conclusions, and research in these journals. Graphic organizers or other worksheets can be stapled in the journal. This tool will allow students to investigate over time as they can refer back to past experiences in an organized and cohesive way. Ideally, the journal will be a teacher or student-made book of pre-printed sheets that prompt students to record essential components of any investigation (question, materials used, prediction, observations and data, what was discovered, etc.)
* Drawing Materials – Students will use these to record detailed observations.
* Writing Materials – Students will use these to label or annotate observations, designs, and other important creations. Writing materials include pencils, software, and computer access.
* Clear Plastic Cups – Students will use these to collect and observe precipitation.
* Thermometers – Students will use these to collect data about temperature patterns.

# What is Weather?

### Goal

Students will construct knowledge about aspects of weather.

### Objectives

Based on experiences in the investigation, students will be able to do the following:

* Describe that cloud cover, wind, temperature, and precipitation are some factors that we use to describe the weather

### Materials

*Cloud Dance* by Thomas Locker

Class weather chart

Weather symbols to use with chart

Science journals

Drawing materials

### Discussion

1. Read the book Cloud Dance.
2. Pose the question, “What words did you hear in the story that are weather words, or words that make you think about weather?” Reread the text if necessary. List the words on chart paper. They may include the following:

* Clouds
* Sky
* Season
* Changing
* Wind
* Autumn
* Winter
* Snow
* Mist
* Warm
* Summer
* Sunlight
* Storm
* Rain
* Water

1. Pose the question, “What is weather?” Help the students formulate a definition based on the words they shared and the ideas in the book. The definition might be as follows:

*Clouds, wind, temperature, rain, and snow are some of the things that make up our weather. Weather can change every day.*

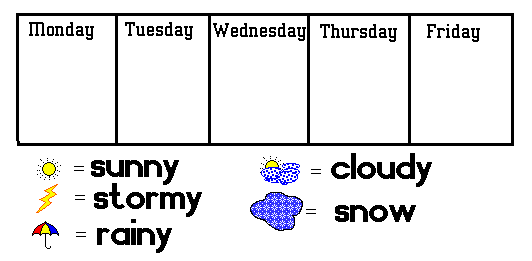
1. Pose the question, “What are some weather changes that you have seen or felt?” Allow students to share thoughts and experiences such as a first snowfall of the year, a storm that moved in recently, walking out to find frost on the ground, etc.
2. Make the statement, “We will investigate ways in which the weather changes from day to day. We will use this class chart to keep track of weather changes.”
3. Make the statement, “We will use symbols to represent the kinds of weather we observe.”
4. Pose the question, “What is a symbol?”
5. Pose the question, “What symbols might we need to represent the weather you think we will observe this week?” Record symbols that students suggest.

### Setting the Stage for Inquiry

1. Display the following materials for the class:

* Non-fiction texts about weather
* Science journals (with copies of the weekly chart attached)
* Drawing materials
* Large class weather chart (such as the following)
* Weather symbols (include symbols that students suggested that may include the following) to use with chart

**Weather From Day to Day**



2. Ask students to think quietly to themselves about what they wonder as they look at the displayed materials.

3. Explain that students will set the stage for inquiry by developing the questions they would like to answer in the larger investigation. The following prompt may be helpful in directing their exploration as you set the stage for the more specific inquiry investigation to come:

*“As you look at the chart, symbols, and books about weather, share and record any questions that you have about what you see, what you will do, or what you wonder about. Those questions will be very important as our investigation continues.”*

1. Model the process of formulating questions such as “What will the weather be like this week?”
2. When students understand the task, allow them to begin exploring the materials. Remind them to discuss and/or record questions that they wonder about as they work.
3. After students have had an opportunity to explore the materials and generate questions, gather them together and allow students to share their questions with the group.
4. Record questions on chart paper.
5. Help students classify the questions in ways that will isolate those that are testable and most relevant given the goals of the investigation. For example, you may choose to create a simple chart or web of questions that will allow the class to group some questions under the heading “Questions about Rain” and “Questions about Clouds” among others. Questions that are more relevant to a later investigation of seasonal changes (rather than daily or weekly changes) can be grouped under the heading “Questions about Seasonal Changes.”
6. Add good questions to model or support the list generated by the students in order to guide the investigation in the way you want. The following are examples of appropriate questions for this investigation:

* What will the weather be like this week?
* Will the weather stay the same for the week?
* How will the weather change?
* Will it rain?
* Will it be windy?
* Will it be warm/cool?
* How many days will be sunny?

7. Make the statement, “Although each group may select a slightly different question, we will all choose questions that can be answered using information from our class and journal charts and observations that we make.”

### The Inquiry Investigation

1. Provide time for groups to select and record the question with which they will begin their investigation in their science journals. Explain that they may investigate additional questions after they have had a chance to explore their first question. Assist students in choosing questions that relate to data from simple observations and information that can be represented on the class and individual journal charts.

2. Pose the question “As a scientist, how might we investigate these questions?” Encourage them to focus the discussion on the scientific method. Review the scientific method and its purpose. Refer to a large chart or poster with the scientific method presented in student-friendly language (see the last page of this document).

|  |  |  |
| --- | --- | --- |
| **Scientific Method** | **Design Process** | **Universal Systems Model** |
| State the Problem | Identify a Need or Problem | Goal |
| Gather Information and Develop a Hypothesis | Research the Need or Problem and Develop Possible Solutions | Input |
| Perform an Experiment/Investigation | Construct a Prototype | Processes |
| Collect Data | Test and Evaluate the Solution | Output |
| State the Conclusion | Communicate the Solution | Feedback |
| Repeat the Experiment | Redesign | Make Necessary Changes and Repeat the Process |

6. As students conduct their investigations, circulate and facilitate conversation that promotes the scientific method and allows for student ownership of ideas. The following are sample prompts teachers may use to facilitate conversation:

* What question are you investigating?
* What is your hypothesis? (Example: What do you think the temperature might feel like tomorrow?)
* How will you perform investigate your question?
* What will you observe?
* How will you record what you see and feel?
* How can you share your observations with others?
* Did your group mates find the same things?
* Was your hypothesis correct? Why or why not?
* What is your response to your original question?

***Synthesis***

1. Gather the class together with their journals on a weekly basis.

2. Allow students time to present their observations.

3. Pose the question, “What did you find out about the weather this week?”

4. Once a couple of weeks worth of data have been collected, pose the question, “How does the weather this week compare with the weather last week?” Save the charts in order to identify long-term patterns.

# Using Tools to Measure Weather: Wind

### Goal

Students will construct knowledge about simple tools that can be used to collect data about the weather.

### Objectives

Based on experiences in the investigation, students will be able to do the following:

* Design a simple tool to determine if wind is blowing
* Use the tool to make observations about wind.

### Materials

Non-fiction texts about wind and other aspects of weather

Lightweight materials that are easily moved by wind such as Styrofoam balls, feathers, or cotton balls

String

Tape

Popsicle sticks

Science journal

Colored pencils or crayons

### Discussion

1. Read a non-fiction text about wind.
2. Pose the question, “What is wind?” Help students generate a simple definition and record it on chart paper. A simple definition might be as follows:

*Wind is moving air.*

1. Pose the question, “How do we know that wind is blowing?” List suggestions on chart paper. Suggestions may include the following:
   * My hair blows.
   * I see leaves blowing.
   * I feel wind on my face.
   * I see branches bending as the wind blows them.
   * I see ripples on the water.
2. Make the statement, “These ideas tell us that wind is moving. The moving air pushes other things around like leaves and our hair.”
3. Make the statement, “We will investigate the wind. We will make some tools that will help us measure how much the wind is blowing.”

### Setting the Stage for Inquiry

1. Display the following materials for each group of students:

* Non-fiction texts about wind and other aspects of weather
* Light-weight materials that are easily moved by wind such as Styrofoam balls, feathers, or cotton balls
* String
* Tape
* Popsicle sticks
* Science journal
* Colored pencils or crayons

2. Ask students to think quietly to themselves about what they wonder as they look at the displayed materials.

3. Explain that students will set the stage for inquiry by developing the questions they would like to answer in the larger investigation. The following prompt may be helpful in directing their exploration as you set the stage for the more specific inquiry investigation to come:

*“At your area you have some materials. You will find that as you explore these materials, you may wonder about certain questions. As you explore, share and record any questions that you have about what you see, what you will do, or what you wonder about. Those questions will be very important as our investigation continues. Decide with your group how you will use the materials in order to investigate the questions.”*

1. Model the process of formulating questions such as “How can we make a tool that will tell if there is wind?”
2. When students understand the task, allow them to begin exploring the materials. Remind them to discuss and/or record questions that they wonder about as they work.
3. After students have had an opportunity to explore the materials and generate questions, gather them together and allow students to share their questions with the group.
4. Record questions on chart paper.
5. Select the questions that are testable and relate to the goals of the investigation. Explain to students that all of the questions are interesting and valuable but some cannot be tested.
6. Group the remaining questions under the heading “Testable Questions about Wind.” Feel free to add good questions to model or support the list generated by the students in order to guide the investigation in the way you want. The following are examples of appropriate questions for this investigation:

* How can we make a tool to measure wind?
* Will there be wind every day?
* Will there be a lot of wind or a little wind during this week?
* Will the amount of wind change each day?
* How will the wind compare from day to day?

### The Inquiry Investigation

1. Provide time for groups to select and record the question with which they will begin their investigation in their science journals. Explain that they may investigate additional questions after the have had a chance to explore their first question. Encourage them to begin with a question that relates to the design of a wind tool.

2. Pose the question “What is an engineer?” Discuss the fact that an engineer makes something that people can use. Pose the question, “As an engineer, how might we investigate these questions?” Encourage them to focus the discussion on the engineering design process. Explain that this process is just like the scientific method, with the only difference being that something is made rather than just investigated. Refer to a large chart or poster with the scientific method and design process presented in student-friendly language (see the last page of this document).

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| --- | --- | --- |
| **Scientific Method** | **Design Process** | **Universal Systems Model** |
| State the Problem | Identify a Need or Problem | Goal |
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| Perform an Experiment/Investigation | Construct a Prototype | Processes |
| Collect Data | Test and Evaluate the Solution | Output |
| State the Conclusion | Communicate the Solution | Feedback |
| Repeat the Experiment | Redesign | Make Necessary Changes and Repeat the Process |

6. As students conduct their investigations, circulate and facilitate conversation that promotes the scientific method and allows for student ownership of ideas. The following are sample prompts teachers may use to facilitate conversation:

* What question are you investigating?
* What materials are available to you during your investigation?
* What is your hypothesis? (What could you do with the materials that would help you find out if there is wind? What do you think you will find when you use this tool?)
* How will you record your hypothesis (diagram, written description, both, etc.)?
* How will you design your tool? What will you do first?
* How will you use your tool to investigate wind?
* What are you doing with your tool?
* What did you observe with your tool? What did your tool show you?
* How will you record what you observed?
* Did your group mates observe something similar?
* What is your response to your original question?
* How can you improve your tool?

***Making Simple Wind Tools***

Students may need support as they design and use their wind tools. If necessary, you may encourage them to construct a tool such as the following:

1. Attach a lightweight object (e.g., Styrofoam ball, feather, cotton ball) to a string using tape or knots.

2. Attach the other end of the string to a Popsicle stick using tape.

3. Blow on the attached object to determine whether it will move in wind.

4. Compare the movement of the object when blown with different amounts of air.

5. Use the tools outdoors to make comparisons from day to day based on how much the swinging object is moved by the wind.

***Synthesis***

1. After students have had an opportunity to use their wind tools, gather the class together with their tools and journals.

2. Allow students time to demonstrate their tools and present some observations.

3. Pose the question, “What was the wind like today?”

4. After students have observed the wind using their tools over time, pose the question, “What do you notice about the wind over the course of the week/last few weeks?” Encourage students to recognize that the wind can vary greatly from day to day.

# Using Tools to Measure Weather: Precipitation

### Goal

Students will construct knowledge about simple tools that can be used to collect data about the weather.

### Objectives

Based on experiences in the investigation, students will be able to do the following:

* Design a simple tool to collect precipitation and compare precipitation amounts
* Use the tool to make observations about precipitation

### Materials

*Water Dance* by Thomas Locker

Non-fiction texts about precipitation

Clear cups

Larger paper cups (the clear cups can be placed inside these to steady the clear cup when placed outdoors)

Permanent markers

Unifix cubes or similar manipulative

Rulers

Science journal with graph paper attached

Colored pencils or crayons

### Discussion

1. Read the book *Water Dance* by Thomas Locker.
2. Pose the question, “Where is there water in our environment?”
3. Pose the question, “How do animals and plants get water in our environment?” Focus the discussion on the fact that water can be found in many places such as streams, lakes, rivers, and may also fall as rain.
4. Pose the questions, “Can you tell when it might rain? How?”
5. Pose the questions, “Can you tell when it has rained recently? How?”
6. Make the statement, “Rain is a form of precipitation, or form of water falling from clouds.”
7. Record the word “precipitation” on chart paper.
8. Pose the question, “What are other types of precipitation (other forms of water) could fall from the sky?”
9. Pose the question, “Do you think snow and rain are alike in any way?”
10. Make the statement, “We will be investigating precipitation. In order to do that, we will need to make a tool that will help us collect precipitation.”

### Setting the Stage for Inquiry

1. Display the following materials for each group of students:

* Non-fiction texts about precipitation
* Clear cups
* Larger paper cups (the clear cups can be placed inside these to steady the clear cup when placed outdoors)
* Permanent markers
* Unifix cubes or similar manipulative
* Rulers
* Double-pan balance
* Science journal with graph paper attached
* Colored pencils or crayons

2. Ask students to think quietly to themselves about what they wonder as they look at the displayed materials. Remind them that they will need to collect precipitation in order to investigate it.

3. Explain that students will set the stage for inquiry by developing the questions they would like to answer in the larger investigation. The following prompt may be helpful in directing their exploration as you set the stage for the more specific inquiry investigation to come:

*“At your area you have some materials. You will find that as you explore these materials, you may wonder about certain questions. As you explore, share and record any questions that you have about what you see, what you will do, or what you wonder about. Those questions will be very important as our investigation continues. Decide with your group how you will use the materials in order to investigate the questions.”*

1. Model the process of formulating questions such as “How can we collect precipitation?”
2. When students understand the task, allow them to begin exploring the materials. Remind them to discuss and/or record questions that they wonder about as they work.
3. After students have had an opportunity to explore the materials and generate questions, gather them together and allow students to share their questions with the group.
4. Record questions on chart paper.
5. Select the questions that are testable and relate to the goals of the investigation. Explain to students that all of the questions are interesting and valuable but some cannot be tested.
6. Group the remaining questions under the heading “Testable Questions about Precipitation.” Feel free to add good questions to model or support the list generated by the students in order to guide the investigation in the way you want. The following are examples of appropriate questions for this investigation:

* How can we create a tool that will collect precipitation?
* How will we be able to tell how much precipitation has fallen?
* Is snow made of water?
* How can we measure how much snow has fallen?
* Do any other types of precipitation fall?

***Important Note***: This investigation may be repeated throughout the year when different types of precipitation are likely to fall. As the season varies, so will the type of questions generated by the students.

### The Inquiry Investigation

1. Provide time for groups to select and record the question with which they will begin their investigation in their science journals. Explain that they may investigate additional questions after they have had a chance to explore their first question.

2. Pose the question “As an engineer, how might we investigate these questions?” Encourage them to focus the discussion on the design process.

|  |  |  |
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| Repeat the Experiment | Redesign | Make Necessary Changes and Repeat the Process |

6. As students conduct their investigations, circulate and facilitate conversation that promotes the scientific method and allows for student ownership of ideas. The following are sample prompts teachers may use to facilitate conversation:

* What question are you investigating?
* What materials are available to you during your investigation?
* What is your hypothesis?
* How will you record your hypothesis (diagram, written description, both, etc.)?
* How will you perform your investigation?
* How could you use the cup to answer your question?
* How might you use the cubes to measure how much rain has fallen?
* How might you use the pan balance to measure how much rain has fallen?
* What will you observe?
* How can you record your observations?
* How can you share your observations with others?
* What is your response to your original question?

Building a Simple Rain/Snow Catcher

Students may need help developing a simple tool to collect, observe, and measure precipitation. The following suggests a simple way to create this tool:

1. Suggest that students use a clear cup to catch rain, snow, or other types of precipitation.

2. Pose the question, “Where might you place this rain catcher so that it can collect rain?”

3. Suggest a spot where the cup can be left on the school property for some time during the day when precipitation occurs or is predicted. The cups should be in a place where precipitation can fall freely and is not blocked by a large tree, building overhang, or other substantial object.

4. Share the procedure for collecting precipitation with parents if students will be collecting precipitation at home rather than during the school day. In this way you can offer suggestions for transporting the collected precipitation to school such as in a plastic baggy with the student’s name. The precipitation can be transferred to a clear cup in the classroom during science time for observation and measurement. **The benefit of collecting samples at home is that students will find a variety of precipitation amounts based on where they live, where they placed the cup (e.g., Was the cup blocked by an overhanging tree?), and the amount of time the cup was left outside.** These variables help to generate rich conversation.

5. Once precipitation has been collected, students can measure it by stacking cubes beside the cup up to the water level or using a ruler. Students can also measure the precipitation by placing the cup with the water in it on a double pan balance and using manipulatives such as cubes or bears to quantify and compare amounts. If students are focusing on questions about snow, they should take measurements before and after melting.

6. Students can keep track of amounts using simple graphs or charts.

***Synthesis***

1. Gather the class together with their journals after precipitation has been collected.

2. Allow students time to present their observations.

3. If students collected different amounts of precipitation, pose the question, “Why do you think some of had more or less precipitation in our cups than others?” Focus the discussion on objects that may have blocked the cup, wind that may have blown the precipitation in a direction that prevented it from entering the cup, or spills that may have occurred while transporting the precipitation to the classroom. If the students collected samples from home, help the class to arrive at the conclusion that different amounts of precipitation fell in different locations.

4. After a number of collection opportunities, pose the question, “What type of precipitation was most common during this time of the year?”

1. Pose the question, “What are some other types of precipitation that we might collect over the course of the year?” Help students to generate a list of various forms of precipitation including the following:
   * Rain
   * Sleet
   * Freezing rain
   * Hail
   * Snow
2. Pose the question, “What do you know about precipitation?” Focus the discussion and class list on the following:
   * Precipitation is any form of water that falls from the clouds.
   * Precipitation happens when water drops or ice crystals grow heavy enough

to fall.

* + When water drops are in a cloud they are very small.
  + Rain is the most common type of precipitation in our area.

# Using Tools to Measure Weather: Temperature

### Goal

Students will construct knowledge about simple tools that can be used to collect data about the weather.

### Objectives

Based on experiences in the investigation, students will be able to do the following:

* Use a thermometer to measure temperature.
* Collect weather data using a thermometer.

### Materials

Non-fiction texts about weather

Cardboard teacher demonstration thermometer

Student thermometer copies (see appendix and photocopy)

Coloring materials for shading in student thermometers

Student thermometers (functional)

Cup of ice water or very cold water

Cup of warm water

Cup of sand or soil (optional)

Science journal

### Discussion

1. Display the large teacher demonstration thermometer.
2. Pose the question, “What is this?” Help students identify it as a thermometer.
3. Pose the question, “What do you think this tool is used for?” Focus the discussion on the fact that the thermometer is used to measure temperature.
4. Pose the question, “What is temperature?”

***Important Note***: The actual definition of temperature is far too complex for first grade students. Temperature is the average amount of kinetic energy (motion) of each molecule in a substance. Students at this age will most likely tell you that temperature is how hot or cold something might be. This definition is perfectly appropriate for this age level.

1. Make the statement, “There is a liquid in a thermometer that expands (moves up) when it is warm and condenses (gets smaller) when it is cold. We can use this tool to measure the temperature of air, water, and other substances.”
2. Pose the question, “Look at my thermometer. What do you think these numbers on the side tell us?” Focus the discussion on the fact that the numbers are called degrees and that we use these numbers to describe the temperature.
3. Hand out the student thermometer copies and coloring materials.
4. On the teacher demonstration thermometer, use the red strip to show a particular temperature. Make the statement, “Use a color to match my temperature on one of your thermometers.”
5. Pose the question, “Can you tell me what the temperature is on the thermometer?” Help students to use the word “degrees” following the temperature number.
6. Record the temperature on chart paper in two ways as follows:
   * 50 degrees
   * 50˚
7. Make the statement, “The little circle at the upper right hand corner of the temperature is the symbol for degrees. We can use that symbol instead of writing out the whole word.”
8. Model some additional temperatures for students to replicate and share.

### Setting the Stage for Inquiry

1. Display the following materials for each group of students:

* Non-fiction texts about weather
* Student thermometer copies (see appendix and photocopy)
* Coloring materials for shading in student thermometers
* Student thermometers with Celsius side covered up (functional)
* Cup of ice water or very cold water
* Cup of warm water
* Cup of sand or soil (optional)
* Science journal

***Important Note***: Explain to students that you have covered one side of the thermometer because it contains a different system for measuring temperature. Explain that the covered side is a scale used by scientists. Describe that the class will use the side known as the Fahrenheit scale because it is the one used on TV, radio, and in newspapers to report the temperature.

2. Ask students to think quietly to themselves about what they wonder as they look at the displayed materials.

3. Explain that students will set the stage for inquiry by developing the questions they would like to answer in the larger investigation. The following prompt may be helpful in directing their exploration as you set the stage for the more specific inquiry investigation to come:

*“At your area you have some materials. You will find that as you explore these materials, you may wonder about certain questions. As you explore, share and record any questions that you have about what you see, what you will do, or what you wonder about. Those questions will be very important as our investigation continues. Decide with your group how you will use the materials in order to investigate the questions.”*

1. Model the process of formulating questions such as “What is the temperature of the sand?”
2. When students understand the task, allow them to begin exploring the materials. Remind them to discuss and/or record questions that they wonder about as they work.
3. After students have had an opportunity to explore the materials and generate questions, gather them together and allow students to share their questions with the group.
4. Record questions on chart paper.
5. Select the questions that are testable and relate to the goals of the investigation. Explain to students that all of the questions are interesting and valuable but some cannot be tested.
6. Group the remaining questions under the heading “Testable Questions about Temperature.” Feel free to add good questions to model or support the list generated by the students in order to guide the investigation in the way you want. The following are examples of appropriate questions for this investigation:

* How do we use a thermometer?
* What is the temperature in the room?
* What is the temperature of each of the substances in the cup?
* Will the temperature of the substances in the cup change over time?
* How does the temperature of the cold water and the warm water compare?
* How would the temperature change if the substances in the cup were mixed together?

### The Inquiry Investigation

1. Provide time for groups to select and record the question with which they will begin their investigation in their science journals. Explain that they may investigate additional questions after the have had a chance to explore their first question.

2. Pose the question, “As an scientist, how might we investigate these questions?” Encourage them to focus the discussion on the scientific method.

|  |  |  |
| --- | --- | --- |
| **Scientific Method** | **Design Process** | **Universal Systems Model** |
| State the Problem | Identify a Need or Problem | Goal |
| Gather Information and Develop a Hypothesis | Research the Need or Problem and Develop Possible Solutions | Input |
| Perform an Experiment/Investigation | Construct a Prototype | Processes |
| Collect Data | Test and Evaluate the Solution | Output |
| State the Conclusion | Communicate the Solution | Feedback |
| Repeat the Experiment | Redesign | Make Necessary Changes and Repeat the Process |

6. As students conduct their investigations, circulate and facilitate conversation that promotes the scientific method and allows for student ownership of ideas. The following are sample prompts teachers may use to facilitate conversation:

* What question are you investigating?
* What is your hypothesis?
* How will you record your hypothesis (diagram, written description, both, etc.)?
* How will you use your tool to investigate temperature?
* What happens to the liquid in the thermometer when you place it in the cold water?
* What happens to the liquid in the thermometer when you place it in the warm water?
* What does the liquid in the thermometer tell us about the temperature?
* What are you doing with your tool?
* What did you observe with your tool? What did your tool show you?
* How will you record what you observed?
* Did your group mates observe something similar?
* What is your response to your original question?

***Helping Students Use a Thermometer***

1. Be sure that students recognize that the liquid goes up in warmer substances and goes down in cooler substances.
2. Be sure that students realize they should read the number adjacent to the top of the liquid line in the thermometer.
3. Help students read temperatures by rounding off the number to the nearest ten-degree mark. If they are ready, you can encourage students to predict what number would be in between the ten degree markers in order to help them arrive at a more accurate reading.

***Synthesis***

1. After students have had an opportunity to investigate using the thermometers, gather the class together.

2. Allow students time to share their findings.

3.Summarize important findings including the following:

* + Different materials have different temperatures.
  + Temperature changes as substances become warmer or cooler. (i.e., As the ice melted in the ice water, the temperature began to slowly increase. The water was becoming warmer.)
  + Cold substances make the liquid in the thermometer go down.
  + Warm substances make the liquid in the thermometer go up.
  + Cold substances have low temperatures.
  + Warm substances have higher temperatures.

1. Pose the question, “Can we use the thermometers to measure the temperature outside?”
2. Pose the question, “Why would it be helpful for someone to know the temperature outside?” Focus the discussion on how knowing the temperature can help you make immediate decisions about what to wear or whether you will be able to do certain activities outdoors, as well as long-term decisions based on temperature patterns such as when to plant a garden or plan a vacation.

***Extending the Investigation to Daily Weather Charting***

Allow the students to take their thermometers outdoors on a regular basis in order to add authentic data to their daily weather charting. Once a fair amount of data has been collected and charted or graphed, students can make predictions and draw conclusions on short-term weather and seasonal patterns of temperature.

# Evaluating Understanding

The following pages include key question templates that may be used or adapted, performance criteria for student responses, and student/teacher conference sheets to help students improve their responses.

### How Can Key Questions and Performance Criteria be Used?

Key questions can be administered in the following ways:

* Before a unit to assess overall prior knowledge of all topics
* Before specific investigations in a unit to assess prior knowledge of concepts
* During investigations to aid activation of prior knowledge
* During investigations to remind students of the essential understandings
* Before, during, or after as a component of the writing portfolio if the response goes through the writing process
* After an investigation to identify misconceptions students may still have
* After an investigation to inform instruction based on student misconceptions
* After an investigation as an assessment of the program effectiveness and student progress

Students should be able to answer the following key questions by the end of the unit:

* How would you describe the weather?
* How does the weather change over the course of a few days?
* How does the weather change over the course of the seasons?
* What seasonal patterns do we have in New England?
* What tools can we use to measure weather patterns?

***Collecting Evidence About Student Responses to Key Questions***

|  |  |  |
| --- | --- | --- |
| **Student Name** | **Question #1:**  How would you describe the weather today? | **Question #2:**  What tools can we use to measure the weather? |
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***Collecting Evidence About Student Responses to Key Questions***

|  |  |  |
| --- | --- | --- |
| **Student Name** | **Question #3:**  What was the weather like this week? | **Question #4:**  What was the weather like during this season? |
|  |  |  |
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***Collecting Evidence About Student Responses to Key Questions***

|  |  |  |
| --- | --- | --- |
| **Student Name** | **Question #5:**  How did the weather change over the seasons we have had? | **Question #6:**  What seasonal patterns do we have in New England? |
|  |  |  |
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**Performance Level Criteria for Science and Technology Engineering**

|  |  |  |
| --- | --- | --- |
|  | **Understanding and Reasoning** | **Communication** |
| Novice | * No response, or the response has no relationship to the task. * Inappropriate concepts are applied (provisions that are not needs such as soft leaves for lining the nest) * Evidence is not used to support the response or has no relationship to the task. | * No communication, the communication cannot be understood, or it is unrelated. * Organizes ideas in simple formats such as lists, outlines, or summaries with significant support. * Uses everyday language, simple vocabulary, and the forms of spoken language to describe or discuss. * No use, or mostly inappropriate use, of terminology. * Needs intensive support to generate a response. |
| Apprentice | * The response is not complete or includes only some of the needs provided by the habitat. * The response vaguely suggests that the student recognizes that the habitat provides for all of these needs. * Some evidence is used to support the response or a vague reference is made to the evidence | * Incomplete communication. May not be clearly presented. * Some use of scientific terminology appropriate to the task. * Use of simple organizational patterns. * Begins to form ideas or state a position in a short and direct manner lacking supporting details. * Communicates in a simple manner using a number of the basic conventions of language. * Peer-conferences for errors; reviews work for content and/or form with assistance. |
| Practitioner | * The response addresses all of the needs provided by the habitat including food, water, shelter, and air. * The response shows that the student has a broad understanding * Evidence is used to support the product or performance. | * Clear communication. * Employs effective use of visual organizers or representations to support the response. * Organizes materials with a clear, well-defined structure. * Develops ideas or positions of his or her own. * Effective use of terminology. * Communicates using many of the grade appropriate conventions of written language. * Revisits and revises to make ideas or organization clearer. |
| Expert | * The response completely addresses all components presented in the task. * The response shows a deep understanding of the task including the ability to identify multiple examples of supporting evidence. * The response includes evidence for the purpose of comparison or contrast of other organisms | * Clear, effective communication detailing how the thought process was refined as it was developed (development from general to specific details, etc). * Clear and thorough presentation of concepts so that audience does not need to infer. * Visual organizers or representation is actively used as a means of communicating ideas related to the development of the task. * Precise and appropriate use of terminology. * Use of sophisticated approaches to organizing materials such as strong supporting details. * Develops ideas or positions that are striking, original, and well presented. * Uses an appropriate style, tone, format or genre with consistency. Communicates with an excellent command of the grade appropriate conventions of written language. * Self-edits, responds positively to critique, and is willing to revise. |

**Student/Teacher Conference Sheet**

|  |  |
| --- | --- |
| I did the following things well:  Understanding  Communication   * Organized my ideas clearly * Used some scientific vocabulary * Used diagrams, pictures, words, and other ways of communicating my ideas | These things would make this response better:   * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

# Performance Tasks and Products

Create one or more opportunities during the unit for students to demonstrate their understanding through the creation of a product or performance. The following options provide possibilities for students to demonstrate evidence of understanding. A variety of products and performances may be selected based on the different needs and abilities of students. The teacher may select the task or students may choose from a list provided by the teacher.

Performance task criteria are provided on the following page. A student/teacher conference sheet is also provided. Teachers can meet with students before the task is started, during the task, and/or before the task is presented. This will allow ample opportunity for students to become familiar with the criteria and improve their performance to the next criteria level.

**Visual and/or Written**

* Student-generated weather charts
* Scrapbook of weather data
* Journal entries describing weather patterns
* Diagrams or drawings depicting weather data
* Poem describing weather
* Non-fiction picture and/or text book weather patterns

**Oral**

* Puppet show depicting weather changes
* Role playing of various elements of weather such as forms of precipitation
* Slide show about weather patterns
* Weather forecast

Performance Task Conference Sheet

|  |  |
| --- | --- |
| I did the following things well: Understanding  * Explained what I know about\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_      * Explained what I know about\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * Explained what I know about\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Communication  * Organized my ideas clearly * Used some scientific vocabulary such as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   * Used diagrams, pictures, words, and other ways of communicating my ideas. | These things would make this product or performance better:   * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

|  |
| --- |
| **I changed my product or performance in the following ways:** (Check one or more and explain what you did.)   * Evidence of Understanding:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * Organization:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * Vocabulary:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

|  |
| --- |
| **My product or performance has improved because:** |

# Library and Media Research Support Materials

Bibliography

Circle the place where you found your information.



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Bibliography

Places Where I Found My Information



Title of book \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



Title of encyclopedia \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Title of Web site\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



Title of CD-ROM \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Bibliography: Places Where I Found My Information

**BOOKS: Author's Last Name, Author's First Name. Title. Copyright Date.**

**Sample: Smith, Carl. Frogs. 2001.**



\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_\_\_,

Author's Last Name, Author's First Name. Title. Copyright Date

**ENCYCLOPEDIA: "Article tile." Title of Encyclopedia. Copyright Date.**

**Sample: "Cuba." World Book. 2001.**

"\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_." \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Title of article Title of Encyclopedia Copyright Date



**INTERNET: Title of web site.. Internet. Date you used that site.**

**Sample: Boston Globe. Internet. June 17, 2000.**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Internet. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Title of web site Date you used that site.

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**CD-ROM: "Title of article." Title of CD.**

**Sample: "Hawaii." Grolier's CD.**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Title of article Title of CD

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**Research Process Rubric: How Did I Do?**

Name**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |
| --- | --- | --- | --- |
| **HOW DID I DO?** | **INFORMATION WIZARD** | **INFORMATION SEEKER** | **INFORMATION**  **ELF** |
| AS A KNOWLEDGE SEEKER | I know my question.  I can find information on my own in different sources. | I know my question.  I need help finding information. | I need help focusing on my question.  I need help finding information. |
| LEARNING ON MY OWN | I can find resources on my own.  I can find the facts I need. | Sometimes I find resources on my own.  Sometimes I need help finding the facts. | I need help finding resources and finding the facts. |
| CREATING SOMETHING | I know what to do, am eager to share and I do my best creating the product. | I know what to do, but need help creating the product. | I need help understanding what to do and how to create the product. |
| WORKING WITH OTHERS | I listen to the ideas of others.  I share the work. | I share my own ideas, but have trouble listening to other ideas and sharing the group’s work. | I have trouble working with others. |
| USING INFORMATION RESPONSIBILY | I use my own words and ideas.  I cite sources on a bibliography record form.  I am polite and respectful of library resources and equipment. | I need reminders to use my own words and ideas.  I need reminders to cite sources on a bibliography record form.  I need reminders to be polite and respectful of library resources and library equipment. | I need help to use my own words and ideas.  I need help to cite sources.  I need help to be polite and respectful of library resources and equipment. |

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# Managing an Inquiry-Based Classroom

Establishing a management repertoire is essential for the facilitating an inquiry-based environment. Effective repertoires will consist of strategies that are sensitive to the needs and experiences of all children.

Some students will excel at independent experiences while others will feel overwhelmed with the level of responsibility. As a facilitator, being aware of these simultaneous needs and applying appropriate strategies to each will help make the experience a success.

The following are strategies to engage all types of students during inquiry-based work:

**Verbal Strategies**

* Pre-alert for students in regard to upcoming transitions
* Highly specific commands
* Repetitive commands
* Private redirecting
* Peer/group redirecting
* Offering choice from a select list or group of tasks
* Consistent praise
* Using the student’s name in an instructional example
* Redirecting a partial answer
* Providing a statement for a student to complete (“When you look in the tank, you see…”
* Voice variety
* Creating suspense through questioning (“You will never guess what you will find when you look with your hand lens!”)
* Presenting a challenge (“Let’s see if you can…”)
* Enlisting a student as a helper
* Providing specific roles or “jobs” for students within a group
* Personification
* Connecting with a student’s fantasies (“What would the fish tell you about his home?”)
* Acknowledging all responses (“That was a great thought. I heard Jane suggest…”)
* Encouragement (“I really liked the way you labeled that drawing. It helps me to understand your thinking.”)
* Humor
* Dramatizing

**Non-Verbal Strategies**

* Wait-time
* Moving student to a different location
* Hand signals
* Pause and look
* Proximity
* Looking at one while talking to another
* Circulating first to areas where students need redirection
* Eye contact
* Provide an area free from distraction
* Provide props or visual images of key items, words, or instructions

# Familiar Words for Terminology in Science and Technology Engineering

|  |  |
| --- | --- |
| **Term** | **Familiar Word or Model to Convey Meaning** |
| Choose | “Which one…” |
| Circle | Model by drawing a circle around something |
| Compare | “How are they the same?” |
| Contrast | “How are they different?” |
| Construct | “Build” |
| Describe | “Tell me about…” |
| Design | “How will you do it? |
| Engineer | “Builder” |
| Experiment | “Test”, “How will you find the answer?” |
| Explain | “Tell me how…” |
| Give the steps | “What do you do first, second…” |
| Hypothesis | “What do you predict…” |
| Identify | “What is the name of…” |
| Investigate | “Discover” or “find out” |
| Label | “What is the name of…” Model with diagram or picture |
| Notice | “What do you see?” |
| Observe | “Look! What do you see? What is going on?” |
| Organize | Model by putting things in groups by category |
| Persuade | “Tell me why I should agree with you” |
| Predict | “What do you think will happen?” |
| Solution | “What will the answer be?” |
| Write | Model by holding a pencil |

# Modified Version of Two Parallel Processes with Familiar Language

|  |  |
| --- | --- |
| ***Scientific Method*** | ***Design Process*** |
| Question | Question or Problem |
| Look at Materials and Make a Prediction | Find Information and Make a Prediction |
| Experiment | Build |
| Collect Data | Try It and Think About It |
| Share What You Discovered | Share What You Did |
| Repeat the Experiment | Make It Better |

This modified version of the parallel processes can be used with young children. Duplicate on large paper and laminate for long-term display in the classroom. Refer to it each time students are engaged in scientific or engineering investigations.

# Establishing the Routine of Independent Inquiry

By following these steps as you initiate each inquiry investigation, students will become comfortable with the inquiry process.

1. Review the steps of the scientific method or engineering design process.
2. Review the objectives of the investigation (questions that will be explored or tasks that will be accomplished).
3. Model the steps to be taken (opening the science journal to the proper page, selecting necessary tools, etc.).
4. Articulate the procedures or strategies as you model steps.
5. Have students practice with feedback from you.
6. Monitor students as they proceed independently.